TARGET AUDIENCE: Maintenance Engineers and Operations and Engineering Flights

AFCESA A-GRAM

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

99-35 **JULY 1999**

GROUND SOURCE HEAT PUMPS

SYNOPSIS:

Ground Source Heat Pumps (GSHPs) are combination heating/cooling systems which use the energy storage capacity of the earth as a heat source in winter and a heat sink in summer. Other common terms used to describe these systems are Geothermal Heat Pumps and Water Source Heat Pumps. GSHPs absorb low intensity heat from the ground during heating season, transform it to a usable intensity, and transfer it to the building space. The process is reversed in the cooling season, absorbing heat from the building space and transferring it to the ground.

The GSHP industry developed through the residential market and is expanding into the commercial building arena. Several types of system configurations are possible including:

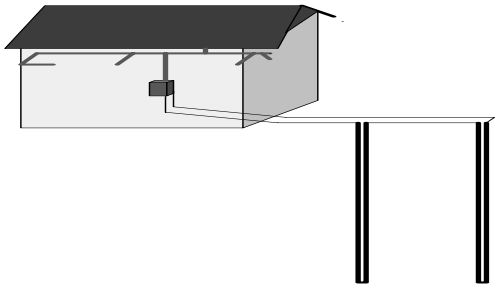
Closed loop
- Vertical ground coupled (see illustration)
- Horizontal ground coupled
- Surface water

Open loop (pump & dump)
- Ground water
- Surface water

The most commonly used system in the Air Force is the closed loop vertical ground coupled. This system uses a closed water loop system with "U" shaped vertical piping ground loops usually sunk 150-300 feet deep to transfer the energy between the ground and the heat pump.

Air Force has installed GSHPs in several locations across the nation. Some critical experience has been gained through these early installations. Important guidelines learned from early projects include:

- Ensure the ground loop is of adequate length. Design of the loop length is calculated considering the ground thermal conductivity. The ground loop is an expensive part of the system, and it is difficult to correct problems once the system is installed.
- Allow only well drillers with GSHP installation experience.
- Select heat pumps with high efficiencies. This will minimize impacts due to deficiencies of other system components.
- Require antifreeze in ground loops of systems when the loop temperature is predicted to fall below 40°F (4°C) at any time during the year. Require antifreeze whenever any portion of the ground loop is exposed to potential freezing temperatures.



- Whenever antifreeze is used, require proper adjustments to the heat pump capacity to allow for reduced heat transfer characteristics of the antifreeze solution.
- Water used to fill the ground loops must have a hardness content less than 100 parts per million. Perform water analysis.
- Require heat pumps to have a capacity 10 percent greater than computed from ASHRAE design conditions. This will account for variance in ground thermal conductivity, building infiltra-tion, building structure thermal properties, etc.
- Require the heat pump maximum design entering water temperatures to be 95°F (35°C).
- Avoid routing ground loop piping through spaces subject to freezing temperatures.
- Avoid air traps in ground loop piping or install air vents at high points in the piping.
- If the GSHPs are installed through a Demand Side Management project, require warranty responsibility to remain with the utility company.

Additional information on design, installation and operation of these systems is available from

- ASHRAE, 1995 HVAC Applications, Chapter 29
- GeoSource Heat Pump Hand-book (available on the Construc-tion Criteria Base)
- International Ground Source Heat Pump Association, Oklahoma State University, (www.igshpa.okstate.edu)

CONTACT:

Mr. Gerald Doddington
HQ AFCESA/CESM
139 Barnes Drive Suite 1
Tyndall AFB FL 32403-5319
DSN 523-6343; Comm 850-283-6343
E-mail: jerry.doddington@afcesa.af.mil